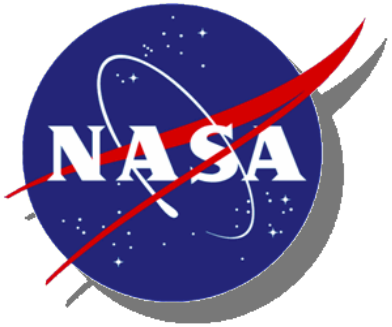

Usability of Operational Performance Support Tools – Findings from Sea Test II

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Test Environment

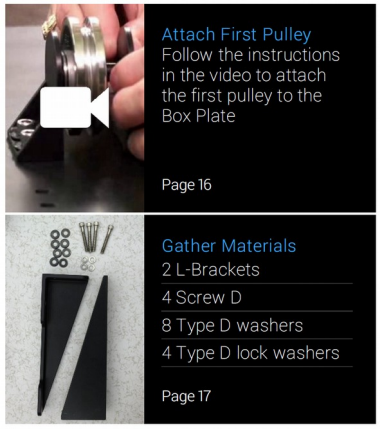
- This study collected subjective feedback on the usability of two performance support tools during the Sea Test II mission, Sept 10-14 2013
  - Google Glass
  - iPAD
- Sea Test II, aka NASA Extreme Environment Mission Operations 17(NEEMO 17) took place in the Florida Aquarius undersea habitat.
- Aquarius dimensions:
  - 43 feet (13.1 meters) in length
  - 9 feet (2.74 meters) in diameter
  - 2,737 feet^3 (77.4 meters^3) in overall pressurized volume
- This confined underwater environment provide an excellent analog for space habitation provi similarities to space habitation such as hostile environment, difficult logistics, autonomous operations, and remote communications.

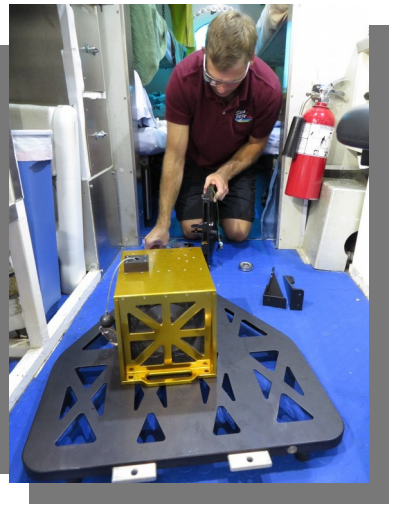
Usability Study Objectives

- The two main objectives:
  - Assess the overall functionality and usability of each performance support tool in a mission analog environment.
  - Assess the advantages and disadvantages of each tool when performing operational procedures and Just-In-Time-Training (JITT).

Method: Operational Tasks

- Two Just-In–Time-Training (JITT) operational tasks were conducted onboard
- First was an equipment assembly and disassembly task:
  - Used a new prototype exercise machine and Google Glass
  - Each crewmember, without prior knowledge of the procedure, assembled and disassembled this exercise machine
  - Demonstrated the use of new technology for real-world tasks
  - Collected subjective questionnaire data





Results: Google Glass Assemble/Disassemble Task

Acceptability of Google Glass Display Size for an Assemble/Disassemble Task

Acceptability of:	Average Median (Range)	Comments
Reading	3.5 (2, 4)	• Text size was small but readable • Google Glass would time out making it difficult to get back to last slide • Only a few words at a time could appear on Google Glass
Viewing Video	3 (3, 4)	• Video quality was adequate but audio was difficult to hear in noisy environment • Zoomed in videos on Google Glass made it hard to put into context (one recommendation to have Birds-Eye-View before zooming) • Eye strain viewing long videos because of looking up and to the right • Difficulty viewing small details in videos
Viewing Static Picture	3 (2, 3)	• Screen size was noted to be too small for viewing details
Combined Picture/Text	3 (2, 4)	• Screen size limited number of words that could be shown together with pictures • Scrolling was reported to jump/skip over some slides that were being viewed

Ratings of 1 = Totally Acceptable to 5 = Totally Unacceptable) for N=6

Results: Google Glass Assemble/Disassemble Task

Acceptability of Google Glass Physical Controls for an Assemble/Disassemble Task

Acceptability of:	Ratings: Median (Range)	Comments
Recording a Video	2 (2, 3)	Easy to start recording video, but if a video longer than 10 seconds, you would need to remember to hit record again
Picture Taking	2 (1, 2)	Easy to take a picture
Changing between Applications	4 (3, 5)	Google Glass is difficult for users that need to wear glasses at the same time. Requires a lot of scrolling/overhead The operations of Google Glass are not as clear as using PC desktop
Amount of Scrolling	4.5 (4, 5)	There is a lot more scrolling within a procedure than there would be on an iPAD or laptop Google Glass timed out to 'Stand by' mode which resulted in a lot of scrolling back and forth. This resulted in the need to go back to the beginning of the procedure and scroll back to the desired slide One person suggested that increasing the time before 'Stand by' mode

Ratings of 1 = Totally Acceptable to 5 = Totally Unacceptable) for

Results: Google Glass Assemble/Disassemble Task

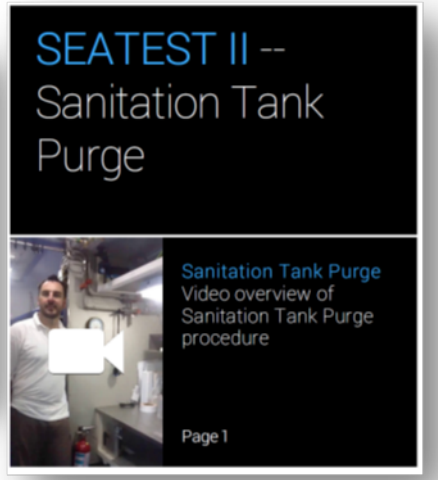
Acceptability of Google Glass Wearability for an Assemble/Disassemble Task

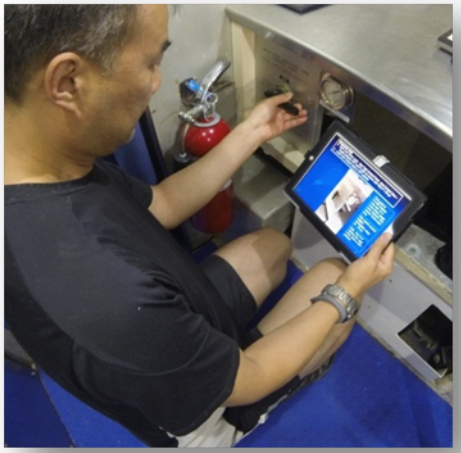
Acceptability of:	Participant Median (Range)	Comments
Comfort	3.5 (2, 4)	• Achieving optimal viewing angle was difficult. It was reported that this adjustment could improve with more experience with Google Glass • Unacceptable for anything over 10-15 minutes of looking up and to the right - the view screen is too far out of the normal vision range and causes eye strain
Fit	2 (2, 3)	• This was generally reported to be acceptable, but one person reported that it was a tight fit on their head
Stability	2.5 (2, 4)	• It was reported by one person that the Google Glass slipped around, especially if moving his/her head

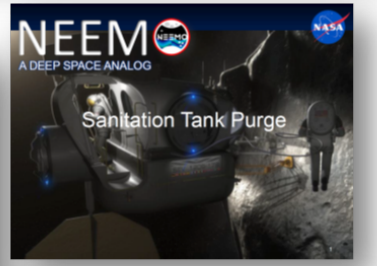
Ratings of 1 = Totally Acceptable to 5 = Totally Unacceptable) for N=6.

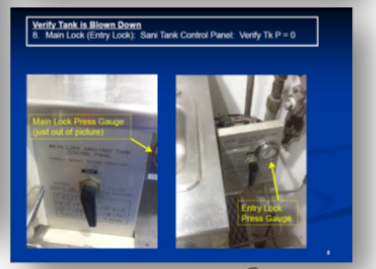
Method: Operational Tasks

- The second task was an operational habitat maintenance task:
  - The task completed was the ‘Sanitation Tank Purge’ which is done daily inside the habitat
  - Each crewmember, used the procedure with Google Glass to complete the task and then viewed the same procedure on the iPAD
  - Compared how the technologies interacted with the displayed procedural information
  - Collected subjective questionnaire data









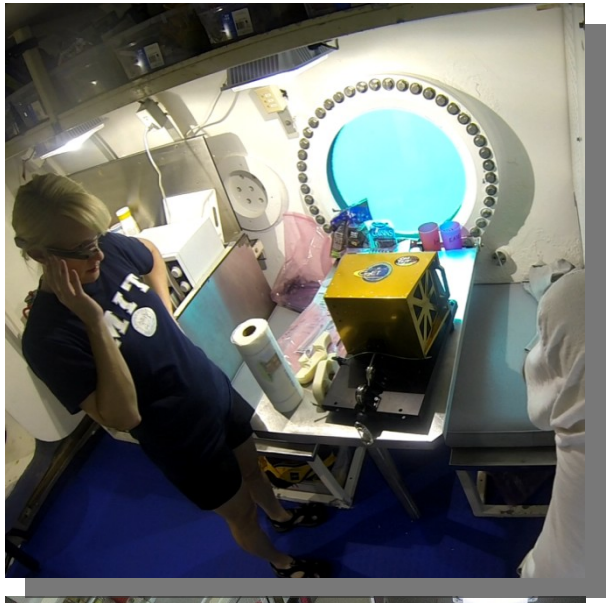
Results: Google Glass and iPAD on Sanitation Tank Purge Task

Subjective Comments Summary

	Google Glass	iPAD
Advantages	• Hands-free mobility • Some operations are easy (e.g. picture taking)	• Text, video and photos larger and easier to read • Touchscreen is very advantageous – intuitive, easy gestures to navigate. • Viewing and recording video and photos were good capabilities. • Easy to swipe through procedures and navigate between applications • Screen size to device size a nice balance: Big enough to read and very portable • Screens do not time out
Disadvantages N=4	• Small text, video and photos limiting amount of information that can be viewed • Eye strain caused by extended periods of looking up and to the right • Scrolling issues (amount and ease of scrolling) • Short battery life resulting in Google Glass timing out	• Need to carry from place to place or Velcro to knee

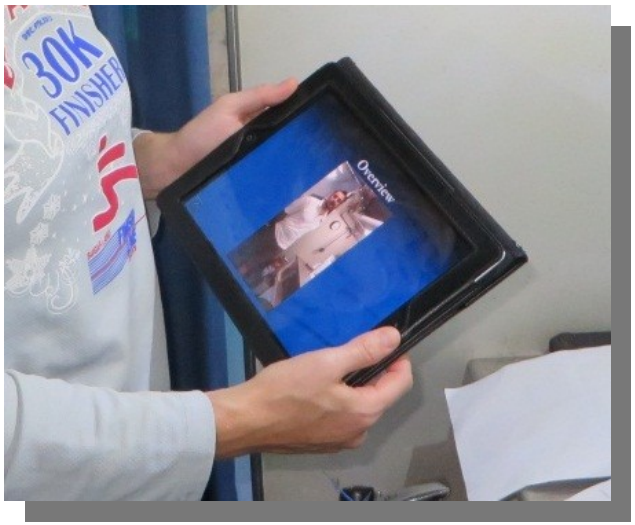
Conclusions

- Google Glass is a promising technology, but needs to overcome battery life, display viewing, and scrolling issues in order to be an operationally useful tool.
- In its current configuration, Google Glass was useful for data collection (e.g. taking a video or picture) but for current operational procedure/task completion, it is not an optimal tool.



Conclusions (con't)

- The iPAD review demonstrated that the iPAD provides features readily adaptable to support operational tasks.
  - The screen size and portability of the iPAD make it a good candidate for a variety of operational tasks.
  - The focus for improvement for the iPAD as a performance support tool involved the portability of the device, such as attaching it to the knee for hands-free operation, rather than the operations display.



Forward Work

- Participate in NEEMO 18 with two objectives:
  - As with SeaTest II (iterative testing), to assess and compare Google Glass and the iPAD using the Sanitation Tank Purge task to examine upgrades to Google Glass hardware and software.
  - Secondly, to demonstrate Google Glass technology in accomplishing a real-world Tele-Mentoring/Virtual Coaching of crew to complete a flight sampling task.
    - Approximately 5 days later, crew will do the same sampling task after viewing an overview video as a refresher and without a procedure or further training.
- Anticipate participation in NEEMO 19
  - To expand the Tele-Mentoring/Virtual Coaching into a more formal test to understand if this type of training method can assist in reducing pre-flight crew training time.
- Complete a Heuristic Technology/Procedure Design Review using Google Glass and iPAD.

Acknowledgments

- Marc Reagan
  - NASA/JSC Mission Operations Directorate, SeaTest II Project Lead for the JIT Training case study
- Craig Russell and Lui Wang
  - NASA/JSC Software, Robotics, and Simulation Division for Google Glass and iPAD support/operations
- ISS Program Support of this study

Questions?